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Human Anxiety in an Aquatic Environment

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ABSTRACT

Certified SCUBA instructors occasionally have students who are less than confident in the water. Sometimes they show overt signs of anxiety, such as "large eyes," jerky movements, etc., but other times they do not. These students have the potential to pose safety problems to any SCUBA instructor. By recognizing covert signs, instructors would be better able to calm and relax the student before entering the water. In an effort to increase safety for the students and instructors, we investigated symptoms of potentially distressed divers.

Cadets enrolled in a basic, open-water SCUBA course were used to assess human anxiety in an underwater environment. We measured heart rate, a proposed criterion measure for anxiety, in a classroom, before entering confined water (pool), in confined water (three times—standing with the face in and out of the water, and on SCUBA for the first time), and before the first open water dive. We created a combined anxiety index, a simple sum using both a physiological measure (heart rate) and a subjective measure (SAI). We also administered pencil and paper instruments (State-Trait Anxiety Inventory, Anxiety Sensitivity Index, demographics).

There were no panic reactions among these cadets during SCUBA training. The main conclusion drawn was that Trait Anxiety Inventory (TAI) scores might provide some predictive power for the occurrence of anxiety reactions during SCUBA training. The TAI acquired during a Classroom session was moderately predictive of our anxiety index, acquired two weeks later at the open Dive Site, explaining about 25% of the variance in the anxiety index. SCUBA instructors might want to consider using the TAI as a rough screening tool for novices entering SCUBA training.

INTRODUCTION

This report summarizes the independent study (Behavioral Sciences 499) performed by C1C Rieben, working with Dr. Miller. C1C Rieben was a National Association of Underwater Instructors- (NAUI) certified SCUBA instructor who taught under the auspices of the Academy's SCUBA Club program. The USAFA SCUBA Club had a fourfold purpose:

1. We provide training and national/international scuba diving certification for the Cadet Wing and the USAFA community at large. At present we train and certify between 300 to 500 cadets, officers, enlisted members, and DoD personnel annually. Certifications include SCUBA Diver, Advanced Diver, Master Diver, Rescue Diver, Assistant Instructor, and Instructor ratings through the National Association of Underwater Instructors (NAUI). We are a sanctioned NAUI training facility.
2. We compete in regional SCUBA meets. We have won first place in both team and individual categories at the Rocky Mountain Regional Competition, which is held at Grand Lake, Colorado annually.
3. We complement USAFA/AH's [USAFA's Athletics Department] elective SCUBA course by completing the open water training portion. We also perform a required military function by training and certifying as open water divers, all of the cadets selected to attend the Navy's Underwater Demolition Training (UDT) course. This training is a prerequisite for the cadets attending UDT school each summer. We also certify cadets who will be going on to Air Combat Controller training.
4. Finally, we support the Academy mission in the broadest sense, because the club officers and instructors receive extensive training and experience in command and leadership. By the very nature of the activity, SCUBA is inherently, both physically demanding and potentially dangerous. It is blatantly dangerous to the improperly or untrained person. As a result, the cadet SCUBA instructors and staff must be conscientious, without fail, in their preparation for and conduct of the training. It is noteworthy to point out that almost all club training is conducted by cadets under the auspices of officer supervisors. [Source: USAFA SCUBA Club website, spring 2000]

Certified SCUBA instructors occasionally have students who are less than confident in the water. Sometimes they show overt of anxiety signs such as "large eyes," jerky movements, etc., but other times they do not. These students have the potential to pose safety problems to any SCUBA instructor. By recognizing covert signs, instructors would be better able to calm and relax the student before entering the water. In an effort to increase safety for the students and instructors, we investigated symptoms of potentially distressed divers. Cadets enrolled in a basic, open-water SCUBA course were used to assess human anxiety in an underwater environment.

In every basic SCUBA instruction session, the topic of panic is addressed. However, a quantitative approach to a correlation between comfort in the water and predictive factors had not been provided to instructors. The goal of this study was to determine if any significant relationship between predictive factors and potential distress in the water existed for new SCUBA students. By knowing of and using a relationship between prior water experience and anxiety in and around SCUBA diving, SCUBA instructors would be better able to identify in advance students that may show signs of underwater panic. By recognizing and preventing the

potential panic situation, which is considered an emergency in SCUBA instruction, instructors would be better able to provide a safe learning environment.

It is known that as anxiety levels go up, so does heart rate in humans. We hypothesized that (1) the heart rate for a person preparing to enter the open water for their first SCUBA dive would be higher than the heart rate of a person underwater in a confined water environment for the first time; (2) the heart rate for a person in confined water for their first SCUBA dive would be higher than the heart rate of a person preparing to enter the water; and (3) that these three rates would be higher than the resting heart rate for the same individual. We also hypothesized that a higher amount of prior water experience (swimming, boating, etc) would be associated with a lower heart rate.

The procedures used in this project took into consideration the thermoregulatory effects in the different environmental conditions. Three of the six heart rate measures were taken in a classroom setting where the differential thermoregulatory effect on heart rate was minimal. Since these three measures were all taken in approximately the same ambient temperatures, thermoregulatory effects were expected to be negligible. Thermoregulatory effects may have influenced the other three heart rates, taken in the pool, in a somewhat repeatable manner. One heart rate was also affected by the diving reflex.

One may estimate anxiety through pencil and paper tests, such as the State-Trait Anxiety Inventory (Peterson and Reiss, 1987). However, there is no pencil and paper anxiety test that is used specifically to assess students' anxiety levels entering basic SCUBA instruction. If there were a way to measure anxiety levels in new SCUBA students, instructors would be better equipped to recognize and watch specific students for potential panic situations during in-water training. These situations represent danger to not only the distressed student, but also the instructor and fellow students in the class.

The results of the study were expected to benefit SCUBA instructors at the United States Air Force Academy. By recognizing how cadet SCUBA students react to an aquatic environment, instructors at the AF Academy may be better prepared to instruct their students in a safer manner. The instructors should be better prepared to intervene before a panic situation becomes dangerous. The results might also be generalizable to non-cadet populations.

METHODS

Experimental Design

This experiment used a repeated measures design. Each subject was measured on a single factor (phase of training) across six different levels. The six levels included:

- The Classroom setting
- Sitting by the pool's edge (Poolside)
- Standing in chest-deep water with face out of the water (Pool-Out)
- Standing in chest-deep water with the face in the water (Pool-In)
- Underwater in a confined water setting on SCUBA (First SCUBA)
- Sitting, before the first open water dive (Dive Site)

The criterion measure, against which we planned to judge the sensitivity of other dependent measures, was heart rate. The other dependent variables included demographics and state anxiety. Trait anxiety scores were to be used as covariate measures. C1C Rieben focused on conducting descriptive analyses of the data, and then Dr. Miller focused on the predictive nature of the data.

Sample Size Calculation

The variance (standard deviation; s.d.) of adult, resting heart rate is about six beats per minute (bt/min; CV = 0.10; e.g., Miller & Horvath, 1976). Our minimally-acceptable anxiety effect size was 9 bt/min (1.5 sd): if heart rate did not increase, due to anxiety, by at least (d_3' = 6 bt/min, d_3' x 1.414 = about) 9 bt/min (Cohen, 1988; with correction for repeated measures), then the effect was not of interest to us. Thus, to ensure adequate confidence (95%; one-tailed) of an acceptable anxiety effect for our independent variable, our minimum sample size was n = 18, which would yield a test power of about 0.90 (ibid. Table 2.3.2, d_3' = 1.0; power will be reduced by intersubject correlations across conditions). Based upon previous SCUBA classes, we expected to have at least 20 subjects. Thus, if mean heart rates did not change significantly across experimental conditions, then we could be reasonably sure that this SCUBA training had little effect on anxiety for this group of subjects.

Materials

No special SCUBA equipment beyond basic SCUBA gear was used, and standard instruction practices were used. We acquired heart rates by 15-sec palpation of the carotid artery conducted by one investigator (AWR).

A background survey acquired basic demographic information from the subjects, including age, sex, class year, and previous experience in flight training, jumping, competitive swimming, and snorkeling (Appendix A).

The Anxiety Sensitivity Index (ASI; Peterson and Reiss, 1987; Appendix B) allows self-estimates of trait-like anxiety levels and is predictive of panic attacks (Schmidt et al., 1997;

Holloway and McNally, 1987). Each of the 16-items on the questionnaire is scored from zero to four, producing a possible range of total scores from zero to 64. For male subjects, "low" anxiety sensitivity was defined as a score of seven or less, and "high" anxiety sensitivity was defined as a score of 23 or more (Reiss et al., 1986, cited in Holloway and McNally, 1987).

The State/Trait Anxiety Index (STAI; Spielberger, 1983) allows self-estimates of trait (TAI) and state anxiety (SAI) levels. Each scale is comprised of 20 questions, and each scale produces a possible range of scores from 20 to 80. Higher scores indicate higher anxiety.

Procedures

We gave two SCUBA classes of cadets at the USAF Academy the opportunity to participate. Each class's training stretched over two weekends. The first weekend included a SCUBA written test on Friday night, and confined water sessions on Saturday or Sunday (Academy's main, upper pool). (The cadets had studied previously the basic academic aspects of SCUBA diving, provided to them by the instructors on CD-ROM.) The following weekend, the SCUBA students went on a field trip to complete their certification with five open water dives in Santa Rosa, NM.

On Friday night, following the SCUBA examination, the volunteers completed consent forms, demographic information, the ASI, and the STAI (both state and trait), and we acquired their resting heart rate. On Saturday (or Sunday), with the subject sitting beside the pool, they filled out the SAI and we acquired heart rate (Poolside). Then, the cadets entered chest-deep water quietly and we acquired their heart rate with their face dry (Pool-Out). Then, without holding their breath enough to perform a modified Valsalva maneuver, participants submerged their face to have their heart rate taken again (Pool-In). There was no more than one-minute of elapsed of time between the two in-water measurements, allowing us to acquire a good estimate of the effect of the diving reflex on heart rate. We acquired the final heart rate of the confined dive day when the cadets first submerged on compressed air as they knelt on the bottom of the pool, breathing and adjusting to the underwater environment in at least ten feet of water (Dive Site). The following weekend, we acquired heart rate in a classroom setting at the dive site, and the cadets filled out the final SAI.

All participants except three followed this schedule during one of the two offered classes. One cadet completed the written test and pool session for the first class, but went on the second offering of the field trip. Two cadets took the SCUBA written test, and the classroom research measures were acquired, on Saturday morning before the pool sessions rather than on Friday night. There may have been unwanted effects of circadian variation in heart rate for these two subjects. There were two missing SAI poolside scores, and one missing poolside heart rate. We replaced these with sample means for that session.

We attempted to control for the effects of changes in ambient environmental temperatures on heart rate. All of the heart rate measures outside the water were taken in a climate-controlled environment at approximately the same air temperature. All heart rate measures taken in the water were taken at the same water temperature in the pool. However, the water temperature of the pool was well below a thermoneutral level for physical inactivity. Thus, we expected that

water-induced fluctuations in heart rate would add to the intersubject variabilities of measured heart rates.

To summarize, we measured heart rate, a proposed criterion measure for anxiety, in a classroom, before entering confined water (pool), in confined water (three times—standing with the face in and out of the water, and on SCUBA for the first time), and before the first open water dive. We also administered pencil and paper instruments (State-Trait Anxiety Inventory, Anxiety Sensitivity Index, demographics).

Participants

We solicited potential subjects from the cadets who wished to become certified in SCUBA diving through the Academy's SCUBA club.[1] Cadets replied to a Cadet Command Center message advertising SCUBA lessons and we compiled a list of names. At least 24 hours before entering any SCUBA training, we sent the cadets on the list an e-mail explaining the experiment and soliciting their participation. After the administration of the written test for SCUBA certification on Friday night, an unranked, cadet (AWR) gave further information to those who expressed interest in participating. The principal investigator was also available to answer non-routine questions. Those cadets who chose to participate then provided informed consent.

The final sample of subjects was a group of 22 male cadets ranging in age from 18 to 23 yr (mean 19.8 ± s.d. 1.5 yr). Six were 4-degrees (freshmen), three were 3-degrees (sophomores), three were 2-degrees (juniors), and ten were 1-degrees (seniors). Three other subjects, including one female cadet, entered the study but opted out as the study progressed.

[1] The research was reviewed by the USAFA Institutional Review Board for human subject protection. The protocol and its associated informed consent document were approved as Air Force research protocol no. FAC2000013.

RESULTS AND DISCUSSION

Heart Rate

The heart rates acquired across the training sessions are shown in Table 1 and Figure 1. A single-factor, repeated measures analysis of variance (BMDP, 1992; program 2V) performed on the raw (15-sec) heart rate data indicated a significant effect of session on heart rate ($F(5,105)=6.03$, $MSe=7.23$, Greenhouse-Geisser $p = 0.0006$). It appeared that the effect of the diving reflex (Pool-Out heart rate minus Pool-In heart rate) was the main source of reliable variance. In fact, a *post hoc* Neuman-Keuls test indicated that both the Pool-Out and First SCUBA mean heart rates were significantly greater than both the Pool-In and Dive Site mean heart rates ($p < 0.01$).

Table 1. Heart rates in beats per minute. Pool-Out and Pool-In represent measurements with the face out of and in the water, respectively. First SCUBA represents the first part of the first SCUBA dive in the pool. $^{***}p < 0.01$

	Classroom	Poolside	Pool-Out	Pool-In	First SCUBA	Dive Site
Mean	67.1	75.5	78.0***	65.1	77.3***	66.7
SD	11.2	11.1	14.7	7.5	15.1	9.5
Minimum	52	52	60	48	52	48
Maximum	96	96	124	76	108	84

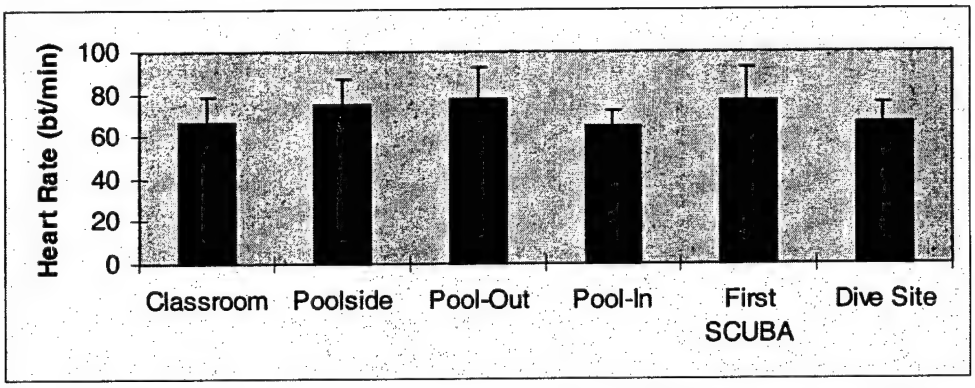

Figure 1. Heart rates in beats per minute, mean ± one standard deviation. See Table 1 for definitions.

The statistically significant difference between the Pool-Out and Pool-In mean heart rates represented the strong, reliable, bradycardic influence of the diving reflex. In this case, the reflex caused a mean 13-bt/min slowing of heart rate. This sensitivity to the diving reflex supported the usefulness of the carotid palpation method for heart rate acquisition in this investigation.

The slight elevation of heart rate in the First SCUBA condition may have represented, primarily, a mild tachycardia triggered by lung inflation (respiratory sinus arrhythmia) secondary to positive pressure breathing.

Our hypotheses with respect to heart rate were not supported.

- The pre-open water (Dive Site) heart rate will be higher than the confined water heart rate on SCUBA (First SCUBA). Actually, there was a statistically significant, opposite effect, due most likely to a mild tachycardic effect of positive pressure breathing as noted, above.
- The confined water on SCUBA (First SCUBA) heart rate will be higher than the pre-confined water (Poolside) heart rate. This hypothesis was not supported. Considering the possibility of a non-anxiety-induced mild tachycardia associated with the First SCUBA measurement, the presence of an equivalent Poolside heart rate may have indicated some mild to moderate Poolside anxiety.
- The three previously mentioned heart rates (Dive Site, First SCUBA, Poolside) will be higher than baseline, resting classroom heart rate. This hypothesis was not supported. Again, considering the possibility of a non-anxiety-induced mild tachycardia associated with the First SCUBA measurement, the presence of an equivalent Classroom heart rate may have indicated some mild to moderate Classroom anxiety.
- As the prior water experience of a subject goes up, the heart rates across the stages of SCUBA training will be lower. This hypothesis was not supported for any one set of reports of prior experience with SCUBA, snorkeling, and competitive swimming experience.

While the relatively low mean Classroom, Poolside and Dive Site heart rates suggested at most mild anxiety on the part of the cadets in the SCUBA class, the maxima across sessions (Table 1) certainly indicated the presence of some moderate anxiety for some individuals within the group. This variability suggested that correlational techniques would be useful in examining the data further.

Demographics

The demographics questionnaire revealed the following reports of previous experience

- Any jump training: 8
- Any flight training: 11
- Any SCUBA diving: 7
- Any snorkeling: 19
- Any competitive swimming: 9

These demographics suggested a relatively high level of group experience with higher-risk and water-associated activities among these 22 male cadets. We note that soaring and jump training are two high-risk cadet activities that require redundant training, culminating in control of one's body against natural tendencies, such as holding a good freefall position vs. flailing widly as you fall rapidly toward the ground. Those cadets who have experienced the sharp adrenaline surges and control requirements associated with these activities seem to be more self-assured than those who have not (personal observations and experience, AWR).

We also note that every cadet at USAFA has completed at least some sort of basic swimming class(es), so all are at least familiar with water activities. Snorkeling is a water activity that

is accessible to most people, as reflected in the high frequency of reports, above. It may be as simple and low-risk an activity as wading into waist deep water along a calm shoreline and donning a mask and snorkel.

Concerning previous SCUBA experience, we note that the participants who checked "yes" most likely had participated only in the USAFA athletic department course. This course consists of only four pool sessions of about 45 minutes each. These sessions were conducted in a very controlled environment with close instructor supervision and definite, visible pool boundaries. The open water environment is very different in that, often, one cannot see the instructor nor the bottom of the dive site.

Anxiety Indices

The cadets' Anxiety Sensitivity Index (ASI) scores from the introductory class session ranged from 5 to 32 (mean 17.9 ± s.d. 7.4) within the possible range of 0 to 64, where a higher score indicates greater anxiety sensitivity. Two cadets reported "low" anxiety (ASI ≤ 7) and six cadets reported "high" anxiety (ASI ≥ 23).

Schmidt, Lerew and Jackson (1997) observed an ASI mean of 4.0 ± 2.9 in Academy candidates undergoing initial Basic Cadet Training (BCT) before their 4-degree (freshman) year. Thus, it appeared, based on the ASI, alone, that the research volunteers from the SCUBA class may have been more prone to panic attacks than the entering Academy class during BCT.

The cadets' TAI scores from the introductory class session ranged from 20 to 63 (mean 34.9 ± 10.4) within the possible range of 20 to 80, where a higher score indicates greater anxiety. The male, civilian college student norm for this scale was 38.3 ± 9.2, and for male military recruits was 44.0 ± 12.2 (Spielberger, 1983). Thus, the TAI suggested that this sample of cadets experienced a normal level of trait anxiety for college students. Schmidt, Lerew and Jackson (1997) observed a slightly higher TAI mean of 42.5 ± 5.3 in Academy candidates undergoing initial Basic Cadet Training (BCT) before their 4-degree (freshman) year.

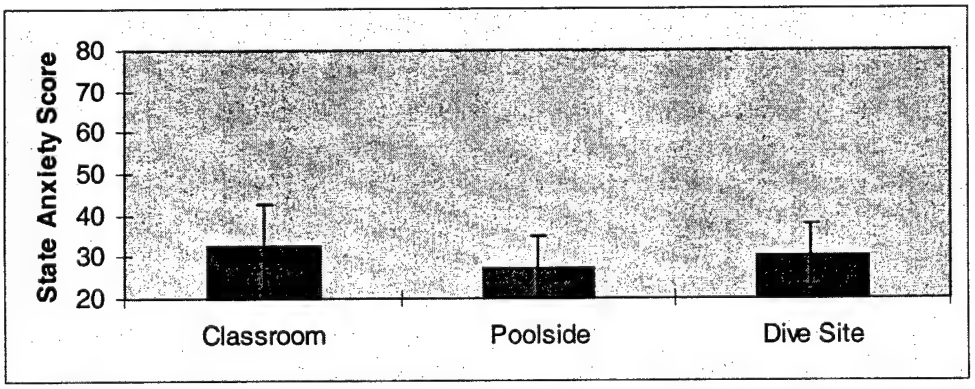

Figure 2. State Anxiety Index scores ± one standard deviation across sessions.

The cadets' SAI during the Classroom session ranged from 20 to 58 (mean 32.4 ± 10.4; Figure 2). The unstressed norms for male, civilian college students were 36.5 ± 10.0, and for male military recruits, 47.0 ± 14.4 (Spielberger, 1983). Again, the cadets appeared to be somewhat less anxious than the norm. The low mean level of state anxiety suggested that test anxiety on Friday evening, after the cadets had completed the test, was not a major factor in state anxiety measurement during this session.

Poolside, before their first donning and use of the SCUBA, itself, the cadets' state anxiety scores ranged from 20 to 52 (mean 27.4 ± 7.6; Figure 2), showing a slight drop from the class session. In the preparation room at the Dive Site, prior to their first open-water dive, the cadets' state anxiety scores ranged from 20 to 44 (mean 30.4 ± 7.5; Figure 2), showing no substantial change from Poolside or the Classroom. The sample mean SAI did not vary sharply as a function of the SCUBA training situations. However, the ranges of scores across sessions suggested that a few cadets might have experienced moderate levels of state anxiety (i.e., around the mid-scale value of 50).

Intra-Session Correlations

The intercorrelation matrix for the Classroom session is shown in Table 2. There was a moderate correlation ($df = 20$, $p < 0.001$) between the TAI and the SAI, and it fell within the expected range (Spielberger, 1983). There was also a moderate level of correlation ($p < 0.01$) between the TAI and the ASI. Heart rate did not correlate well with the anxiety scores.

Table 2. Intercorrelation matrix for the classroom session. $^{***}p < 0.01$, $^{****}p < 0.001$.

	ASI	SAI	TAI	HR
ASI	1.000			
SAI	0.234	1.000		
TAI	0.595***	0.672****	1.000	
HR	0.175	0.198	0.198	1.000

Subsequently, there was virtually no correlation between SAI score and heart rate at Poolside ($r = -0.087$) nor at the Dive Site ($r = 0.168$). The poor correlations between anxiety scores and heart rate for all three sessions did not bode well for using heart rate as a criterion measure for subjective perceptions of anxiety. Our physiological (heart rate) and subjective (ASI, STAI) measures apparently reflected different processes. Of course, heart rate is affected by many factors other than anxiety, including thermoregulatory and physical work demands. Thus, we sought evidence of anxiety across sessions using both the heart rate measure and the anxiety scores.

An Anxiety Index and Associated Predictions

Since the anxiety scores and heart rate seemed to be relatively independent, and both had about the same variability (sd about 5 to 15), we used the equally-weighted sum of heart rate (in bt/min) and SAI score as an anxiety index. We calculated this index for the Classroom, Poolside and Dive Site sessions. We acquired all of these measures from seated subjects in

climate-controlled air. The sum, SAI score plus heart rate, varied across sessions as shown in Figure 3.

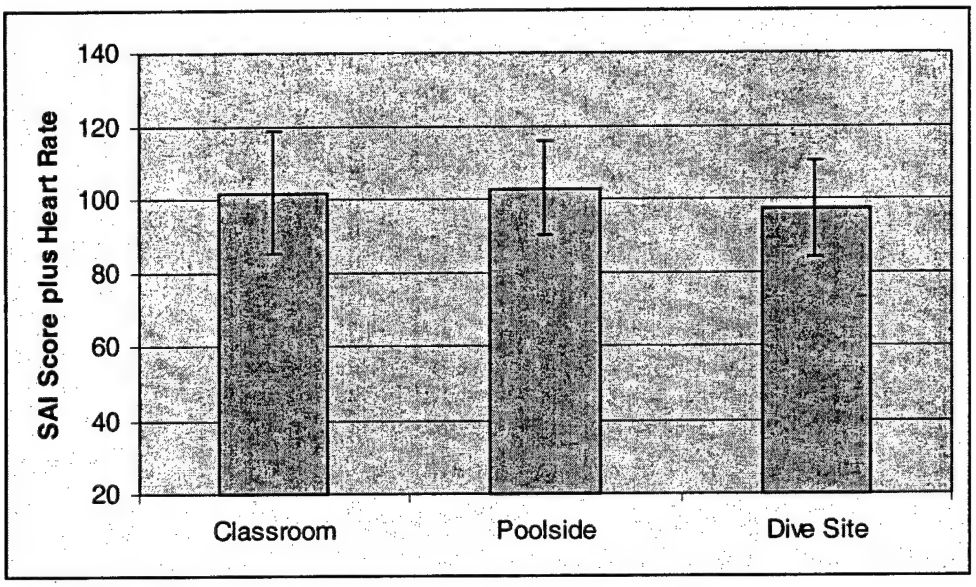

Figure 3. Sum (SAI score plus heart rate) ± one standard deviation across sessions.

We split the group based on their yes-no answers to the activity questions, above, and assessed the yes-no differences for our index, recorded at the Dive Site, with 2-tailed t-tests. There were no large or statistically significant differences. Thus, by themselves, the demographic question dichotomies seemed to have little bearing on the value of our anxiety index.

We also assessed the 7-point ratings for the question, "How good a swimmer are you?" and the agreement with the statement, "I am extremely comfortable when swimming" by calculating the correlations with our index, recorded at the Dive Site (Spearman r). The two correlations were r = -0.301 and r = -0.081, respectively. Neither was statistically significant.

We then assessed the predictive value of the ASI and TAI scores for anxiety during each of those sessions as assessed by that index. We had hypothesized that with prior water activity experience, the heart rates across the stages of SCUBA training would be lower. In line with this *a priori* hypothesis, we assessed the predictive value of the level of experience in water activities for our index. We summed the "yes" answers across the demographic categories, SCUBA diving, snorkeling and competitive swimming, with each "yes" equal to 1 and each "no" equal to 0. The water activity experience score ranged from 0 to 3 with a mean of 1.6 ± 0.80.

The predictive values of the ASI and TAI for this anxiety index, in terms of correlation (Pearson r), are shown in Table 3. There were two moderate and statistically significant correlations. First, the TAI was correlated with the Classroom index reasonably well, as one might expect. Second, the TAI predicted the Dive Site index reasonably well, accounting for about (0.501^2) 25% of the variance in the index. The water experience score provided low to moderate correlations.

Table 3. Correlations of Sum, SAI score plus heart rate, with the ASI and TAI and with water experience. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$, df = 20.

	Classroom	Poolside	Dive Site
ASI	0.263	0.027	0.298
TAI	0.551***	0.169	0.501**
Water	-0.401*	-0.242	-0.317

The relationship between the TAI and the Dive Site index is shown in Figure 4. It appeared that higher TAI scores did predict our anxiety index to a limited degree.

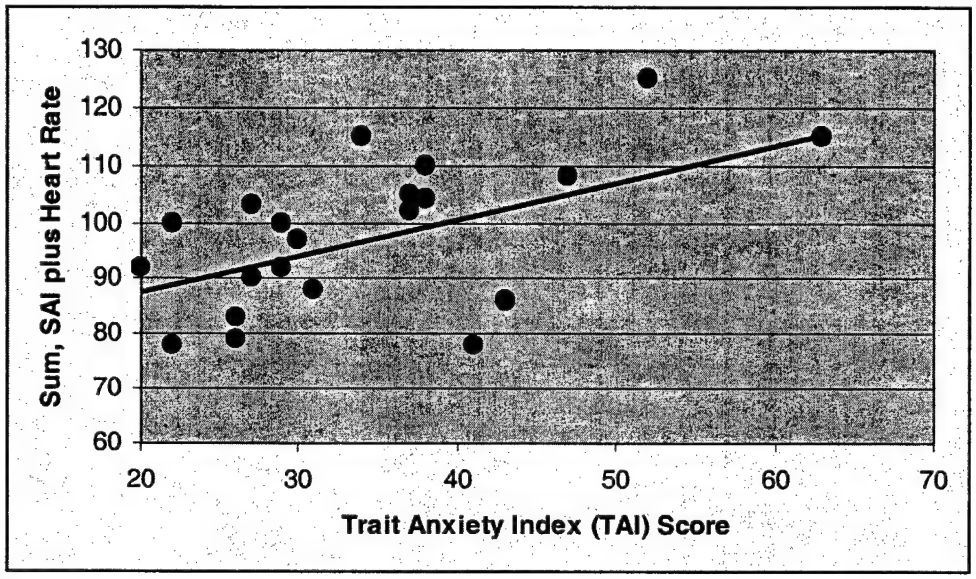

Figure 4. Relationship between the TAI and the Dive Site index. Pearson r = 0.501, df = 20, $p < 0.01$. Index = 75.2 + 0.628 TAI.

The weaker relationship between water experience and the Dive Site anxiety index is shown in Figure 5. Explaining only about (0.317^2) 10% of the variance in the index, water experience provided a small amount of predictive power for Dive Site anxiety, as measured by the index.

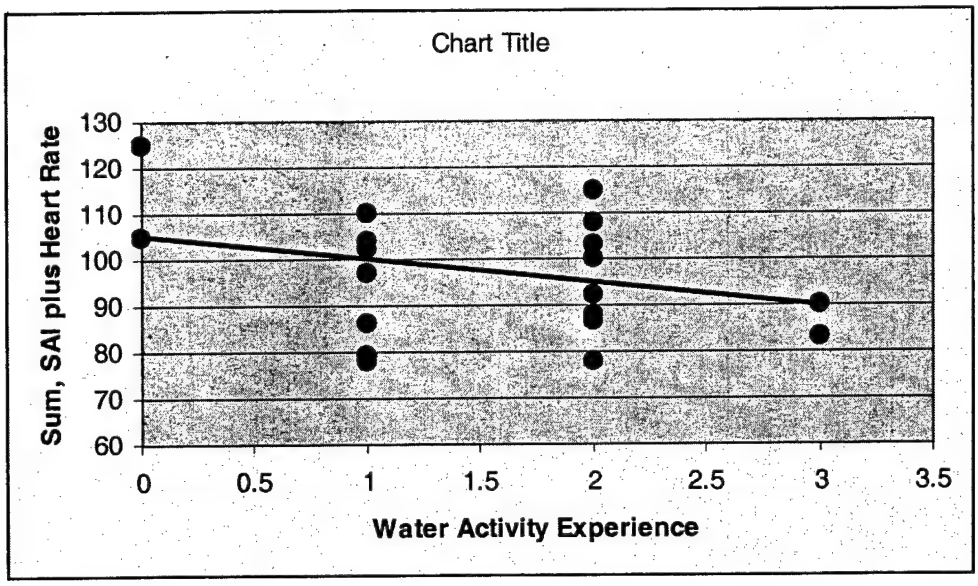

Figure 5. Relationship between water experience and the Dive Site index. Pearson r = -0.317, not significant. Index = 105 - 5.18 TAI.

The correlation between water experience and TAI scores was $r = -0.370$ ($df = 20$, $p < 0.10$). This relationship suggested that, to a very limited degree, those cadets with slightly higher trait anxiety tended to participate less in water activities. This relationship was relevant enough to the relationship between TAI and our anxiety index that water activity experience provided an insignificant contribution in an attempt at multiple regression approach to predicting the anxiety index (BMDP, 1992; program 2R). We tried to use both TAI and water activity experience together to predict the Dive Site anxiety index. We forced water activity experience into the regression equation, after TAI, with the F to accept set to 0.5 and the F to reject set to 6.0. Water activity experience was rejected in backward stepping with $F = 6.70$. Thus, the weak relationship between water activity experience and the Dive Site anxiety index appeared to have virtually no additional value in a predictive sense in the presence of TAI scores.

CONCLUSIONS

There were no panic reactions among these cadets during SCUBA training. We must caution against interpreting the conclusions drawn here concerning the predictive and non-predictive natures of measures too definitively. With that caveat in mind, the main conclusion to be drawn is that TAI scores may provide some predictive power for the occurrence of anxiety reactions during SCUBA training.

The cadets reported relatively low means for their subjective perceptions of trait anxiety and then of state anxiety across the SCUBA training sessions. Some cadets reached the mid-range of the SAI in some cases. Similarly, mean heart rates were relatively low. Many individuals' low heart rates probably reflected high levels of aerobic physical conditioning. However, there were some elevated heart rates in sedentary conditions, suggesting the presence of some anxiety. Thus, we acquired limited, but useful, variation for both the heart rate and anxiety measures. We capitalized on those variations to create a combined anxiety index, a simple sum using both a physiological measure (heart rate) and a subjective measure (SAI).

The TAI acquired during a Classroom session was moderately predictive of our anxiety index, acquired two weeks later at the open Dive Site, explaining about 25% of the variance in the anxiety index. This was an encouraging finding when we consider that at the Dive Site, none of the cadets exceeded the mid-point on the SAI and the mean heart rate was a low 67 bt/min. In fact, the predictive relationship is surprising enough that it begs replication.

However, if a replication is reasonably successful, then SCUBA instructors might want to consider using the TAI as a rough screening tool for novices entering SCUBA training. Based upon the limited data acquired here, there should be no concern if student scores occur only within the lower half of the TAI range (20 to 50). We have no specific data yet concerning those who score in the upper range (50 to 80), but we do have a suggestion of at least moderate anxiety prior to an open water dive for those who would score in that range.

While the direct benefits of such screening remain enigmatic, the cost of using the TAI would certainly be reasonable. Presently, a set (including manual and scoring guide) that allows the buyer to reproduce up to 200 copies of the STAI for personal use within a year may be purchased for about 57 cents per student.

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APPENDIX A

Subject no. _____ Date: _____

SCUBA Dive Training Background Questionnaire

AW Rieben, November 1999

Age: _____ yr

Gender: MALE FEMALE

Cadet class year: 03 02 01 00

Have you experienced any jump training? YES NO

Have you experienced any flight training? YES NO

Have you experienced any SCUBA diving? YES NO

Have you experienced any snorkeling? YES NO

Have you experienced any competitive swimming? YES NO

How good a swimmer are you?

1. Extremely poor
2. Very poor — Select one number: ____
3. Poor
4. So-so
5. Good
6. Very good
7. Extremely good

How closely do you agree with this statement? "I am extremely comfortable when swimming."

1. Decidedly disagree
2. Moderately disagree — Select one number: ____
3. Perhaps disagree
4. Borderline
5. Perhaps agree
6. Moderately agree
7. Decidedly agree

APPENDIX B

Subject No. _____ Date _____

Self-Evaluation Index
USAFA Human-Environmental Research Center
Peterson & Reiss, 1987
For academic research only

Please circle one number per item.

Items	0 = Very Little 4 = Very Much
1. It is important to me not to appear nervous.	0 1 2 3 4
2. When I cannot keep my mind on a task I worry that I might be going crazy.	0 1 2 3 4
3. It scares me when I feel "shaky" (trembling).	0 1 2 3 4
4. It scares me when I feel faint.	0 1 2 3 4
5. It is important for me to stay in control of my emotions.	0 1 2 3 4
6. It scares me when my heart beats rapidly.	0 1 2 3 4
7. It embarrasses me when my stomach growls.	0 1 2 3 4
8. It scares me when I am nauseous.	0 1 2 3 4
9. When I notice that my heart is beating rapidly, I worry that I might have a heart attack.	0 1 2 3 4
10. It scares me when I become short of breath.	0 1 2 3 4
11. When my stomach gets upset, I worry that I may be seriously ill.	0 1 2 3 4
12. It worries me when I can't keep my mind on a task.	0 1 2 3 4
13. Other people notice when I feel shaky.	0 1 2 3 4
14. Unusual body sensations scare me.	0 1 2 3 4
15. When I am nervous, I worry that I might be mentally ill.	0 1 2 3 4
16. It scares me when I am nervous.	0 1 2 3 4